BI-TP 2000/16
MPI-PhT 2000-23

OFF-DIAGONAL GENERALIZED VECTOR-DOMINANCE AND COLOUR-DIPOLES IN LOW-x DIS[a]

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We briefly summarize the equivalence of off-diagonal generalized vector dominance and the colour-dipole approach to deep-inelastic scattering (DIS) in the diffraction region of values of $x \simeq Q^2/W^2 << 1$.

I am happy to be back at Liverpool. Actually, it is the first time after my participation at the 1969 International Symposium on Electron and Photon Interactions. At the time of the 1969 Symposium, the interpretation of electromagnetic interactions of the hadrons in terms of vector-meson dominance [1] was at its height. It was, e.g., theoretically conjectured [2] and experimentally confirmed [1] that the total cross section for photoproduction on nucleons was quantitatively in good approximation related to, and explained in terms of, (diffractive) vector-meson (ρ^0, ω, ϕ) scattering and (ρ^0, ω, ϕ) photoproduction.

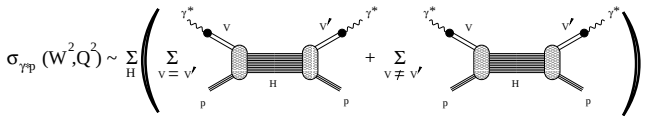

Figure 1: The imaginary part of the forward Compton amplitude in GVD

The 1969 Symposium also saw the rise of the parton model [3], and the failure of pure (ρ^0, ω, ϕ) dominance to explain DIS, or, equivalently, the photoproduction cross section, as soon as the photon acquired a spacelike four momentum, $Q^2 >> m_\rho^2$. Indeed, it was experimentally established that $\sigma_{\gamma xp}(W^2, Q^2)$ behaved as $1/Q^2$ rather than fulfilling the ρ^0-dominance prediction of m_ρ^4/Q^4. Conjecturing the transition of the photon to more massive vector states, experimentally unknown at that time, and their subsequent diffractive interaction

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with the nucleon, lead to generalized vector dominance (GVD) [4] as a theory for DIS in the low $x \simeq Q^2/W^2 << 1$ region, see Fig. 1.

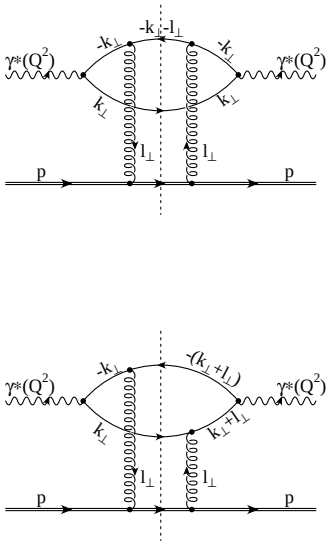

Figure 2: The two-gluon exchange

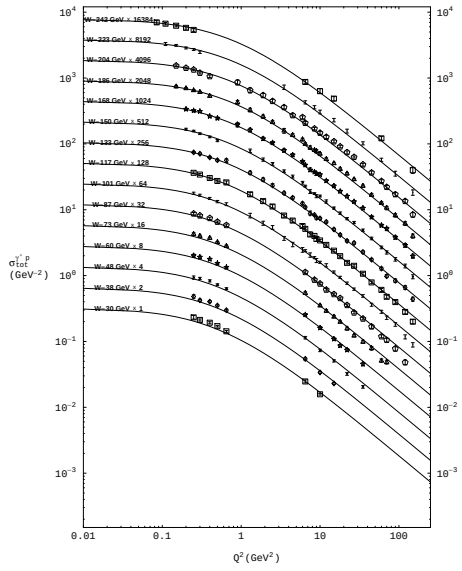

Figure 3: Colour-dipole or, equivalently, GVD results [11] for $\sigma_{\gamma^* p}\ (W, Q^2)$ compared with ZEUS data [16].

It only has been in recent years, with the advent of HERA, that the conceptual basis of the GVD approach was experimentally confirmed by the observation of diffractive production of high-mass $(q\bar{q})$ states in DIS at small values of $x << 1$ and all Q^2. As depicted in Fig. 1, the forward Compton amplitude contains diagonal as well as off-diagonal transitions with respect to (the masses of) the ingoing and outgoing $(q\bar{q})$ vector states. Inconsistencies (sometimes called [5] the "Gribov paradox"), occuring when for simplicity off-diagonal transitions are ignored, twentyfive years ago, lead us to seriously consider [6] off-diagonal transitions with destructive interference between diagonal and off-diagonal contributions. The structure of the forward Compton amplitude thus arrived at [6], found an a posteriori justification [7] in perturbative QCD by the generic structure of two-gluon exchange [8], compare Fig. 2. It turned out that off-diagonal GVD is largely equivalent to[7,9] what has become known as the colour-dipole approach [10]. Our results from ref. [7] were recently generalized [11] to include the W dependence, compare Fig. 3. While our results are formulated in momentum space, closely related work [12,13] is based on transverse position space, compare the talks [14] by Krzysztof Golec-Biernat and Graham Shaw at this meeting.

In his talk [15] on "The Legacy of HERA" at this meeting, Aharon Levy

mentioned that he was "shocked" when he first saw diffractive high-mass events appearing at HERA at small x and any Q^2. Some may have been shocked, others not. As for myself, I allow myself to say that I was not shocked at all, as I saw our theoretical conjectures [4,6] confirmed.

Acknowledgments

It is a pleasure to thank Gorazd Cvetic, Arif Shoshi and Mikhail Tentioukov for a pleasant collaboration and my friends and colleagues at the MPI in Munich for warm hospitality.

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